



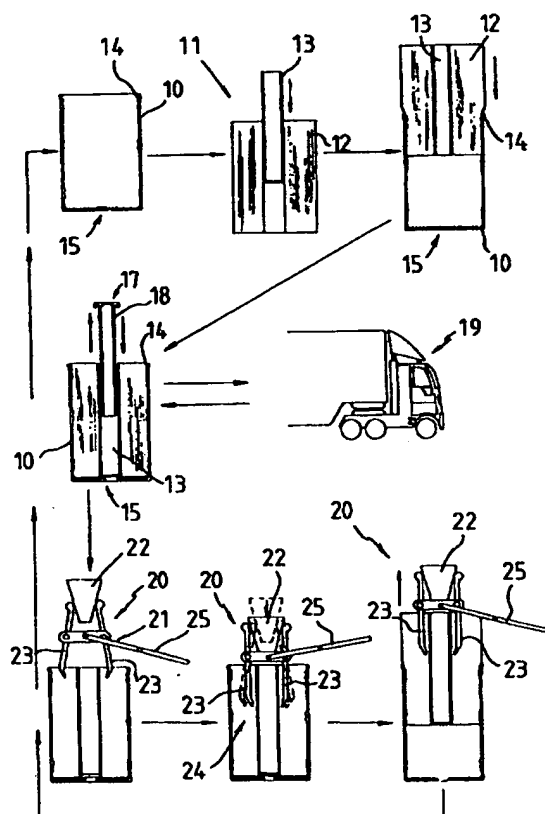
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(54) Title: A FILTER CARTRIDGE AND METHOD

(57) Abstract

A recycling method and a tool utilised with that recycling method. A moulded carbon fibre reinforced plastics material so that the cartridge is sufficiently ridged so that it can be reused. The cartridge is injection moulded using a formulation of 60 % by weight nylon melt resin with chopped glass fibre to 40 % by weight. The resin has a melt temperature in excess of 200 °C. At (11) a filter element is prepared and this involves a 100 % cellulose element (12) into which a reusable moulded or otherwise formed reinforced carbon fibre centre core (13) is pushed. The filter element and core (13) are forced using a press either together or in turn into the cartridge (10). Now the cartridge (10) in the illustrated embodiment includes an annular flare at (14) which operates as a filter element lead-in guide and assists in feeding the filter element into the cartridge. The tool (20) includes a claw assembly (21) utilising a manually operable expander (22) so that upon insertion of the claw assembly (21) into the filter element (11) the expander (22) can be employed to move the jaws (23) of the claw assembly to the position illustrated at (24). A lever (25) is used to extract the claw assembly (21) and thereby the filter element (11) from the cartridge (10). It will be appreciated once the spent filter element has been removed from the cartridge, the cartridge can be reloaded and it can be returned and reused over and over again.



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"A FILTER CARTRIDGE AND METHOD"

TECHNICAL FIELD OF THE INVENTION

THIS INVENTION relates to a filter cartridge and in particular but not limited to a recyclable filter cartridge manufactured from reinforced plastic material using a moulding technique.

BACKGROUND ART

Present methods of on board fuel or oil filtration involve environmentally unfriendly disposal of saturated filter elements.

In one prior art method, filtration of fuel or oil on board a vehicle involves the use of a flexible filter media housed within a disposable metal can. In order to exchange a spent filter the user simply replaces the whole can so that the can and filter media are disposed of together.

In another prior art method the can is not employed and the flexible filter element is placed directly into a fixed permanent housing on the vehicle. This second method is more preferable from an environmental point of view as the contaminated flexible filter element is the only part disposed of but the means of disposal is not altogether clear as it is disposed of by the end user in an uncontrolled way. On the other hand this method is less user friendly as the oily element must be removed and in addition the replacement filter element can be incorrectly installed thereby reducing filter efficiency.

As effective filtration is achieved by making sure the filtrant properly passes through the filter the disposable metal can method is more efficient as the filter element can be placed very tightly within the can under controlled manufacturing conditions. Due to the controlled manufacturing conditions there is little risk of incorrect installation as the geometry of the can and the housing in which the can fits is defined.

Another problem with existing filters is that the filter element tends to break down due to small amounts of water being present. Small parts of the filter media are prone to flow out with the filtrate and can clog apparatus downstream of the filter. Also the filter media to date has not been purpose made with paper rolls usually made for other purposes such as toilet rolls being used. This means the efficiency of filtration has not been optimised.

Another problem arises with the existing can type cartridge insofar as the can is an assembly of parts and a reduction in the number and an improvement in durability of the parts would be desirable.

Present manufacturing techniques involve the insertion of the filter element into the can. The filter element is compressed and upon the application of a press forced into the can. This causes distortion of the filter element in order to obtain the tight fit within the can. The prospect of the can being reused has been proposed by the applicant but this has proved fruitless due to distortion of the can when efforts are made to remove the spent filter element from the can and insert a new filter element into the can. The applicant has carried out experiments with a view to reusing the existing cans but has found the results unsatisfactory due to this distortion of the can.

The present invention also solves problems of can failure known in the existing metal can under certain circumstances. For example, in cold climates at start up the thick oil causes a substantial pressure differential across the can and the can is prone to collapse.

It is an object of the present invention to provide a filter cartridge which alleviates at least to some degree of the above mentioned deficiencies of the prior art in relation to environmental hazards and at the same time ensuring efficient filtration.

It is a further object of the present invention to provide a filter cartridge that provides a useful alternative to the prior art.

Notwithstanding the deficiencies associated with the above referenced disposable can type filter it suffers from other disadvantages and again these have been remedied by the present invention. For example, the metal can is made as a single unit but must include separate spacer means to maintain the filter element away from the can base otherwise the can can become clogged disrupting flow.

OUTLINE OF THE INVENTION

In one preferred embodiment of the present invention there is provided a method for recycling a filter cartridge comprising the steps of:-

- (i) Providing a recyclable filter cartridge;

- (ii) Inserting a filter element into the cartridge;
- (iii) Subsequently inserting the filter cartridge and element contained therein into a filter housing in a vehicle;
- (iv) Carrying out a filtering process with the filter cartridge and the filter element until the element is spent;
- (v) Removing the filter cartridge and spent element from the filter housing;
- (vi) Extracting the spent filter element from the cartridge;
- (vii) Reusing the cartridge by repeating steps (i) - (vii).

10 In another preferred form the invention resides in a filter cartridge being adapted to receive a filter element under compression to form a tight fit between the cartridge and the element, the cartridge being hollow and having a side wall that is sufficiently rigid for multiple use involving repeated insertion and removal of filter elements from the cartridge.

15 The cartridge can be made from any material that enables reusability without distortion of the cartridge. In one preferred form a moulded carbon fibre reinforced cartridge is employed. The cartridge preferably is of integral one piece construction the side wall having an inside surface and there being an inner transverse wall, the inner wall including a filter element support grid allowing
20 flow of filtrate across the inner wall of the cartridge through the support grid while at the same time providing fairly uniform support for the filter element across the inner wall of the cartridge. The inner wall of the can is typically thicker than the side wall to inhibit distortion of the inner wall.

The carbon fibre reinforced plastics used in the moulding process is
25 preferably made up of 60% "Maranyl" nylon produced by Dupont reinforced with glass fibre, to 40%, the nylon melt moulding during an injection moulding process. The cartridge is typically injection moulded at a mould temperature of 90°C–120°C at fast speed to ensure mould fill and to reduce stress in the completed cartridge. A drying time of 3–4 hours at 85°C is typical.

30 Other suitable moulding formulations could be used but should be able to operate without severe deformation at oil temperatures, so a formulation melt

temperature of 260°C is preferred so this provides a margin above normal oil temperature which can usually rise to 200°C or marginally thereabove.

In another aspect, the cartridge holds a filter element for a filter, the cartridge including:

5 an open end forming an inlet for the filter element, a side wall and a second end opposite to the open end of the cartridge;

at least one filter element within the cartridge disposed about a centre tube defining an outflow passage for filtrate so arranged that:

10 a feedstock to be filtered will pass through the inlet to the or each filter element, and the filtered feedstock or filtrate will pass through a cross flow passage into the outflow passage surrounded by the centre tube;

the or each filter element being wound onto the centre tube in sealing engagement with the centre tube and the side wall of the cartridge;

15 the feedstock passes substantially axially through the filter medium to the cross flow passage; and

wherein the or each filter medium comprising a non biodegradable material.

20 Preferably the non biodegradable material of each filter medium is a facial quality tissue paper. More preferably the tissue paper is made from virgin pulp. As virgin pulp has not been treated with colouring the problem of colour contamination in oil is avoided.

The tissue paper may be selected from a range of grades depending on required softness and thickness. The applicant has found that paper softness is a contributing factor to filter efficiency. The reason is that contaminants in oil or
25 fuel stick to softer tissue better. Filters with softer tissues as filter media will therefore retain or trap more contaminants and give a more efficient cleaning effect. In addition softer tissues allow more layers of the tissues in a given space than harder tissues. This quality also improves the cleaning effect. Where the tissue paper for each filter element is to be machine wound the paper tissue must
30 be able to withstand the tension during winding and thereby allows the filter medium to be tightly wound without tearing. The applicant has found that paper

rated at about 17 grams per square meter (GSM) is suitable as it can be wound sufficiently tightly without tearing.

Tissue paper supplied by Carter Holt Harvey and having a product code number of 5799 10/20 2 ply is most suitable for the filter medium as it is non-degradable, made of virgin pulp and rated at 17 GSM.

Each filter medium may be wound onto the centre tube to a roll form. Advantageously the filter medium has one of its ends adhered to the centre tube by an adhesive means. The adhesive means is preferably inert to the lubricant or fuel. An example of the adhesive means suitable for the filter element of the present invention is manufactured by 3M and is identified by 3M Scotch ECR1675. The 3M adhesive does not froth in the presence of oil or fuel.

Using the 17 GSM tissue paper the centre tube onto which the paper is wound can be reduced from 38mm diameter as in the existing toilet rolls to a diameter of 25mm and its length increased from 90mm long in the existing toilet rolls to 170mm long in the wound roll, while maintaining the same external diameter of the toilet rolls used in the existing filter elements. This arrangement of the filter medium of the present invention allows between 43m to 46m of the tissue paper to be rolled and employed per filter element forming an annular roll about 30mm–35mm wide.

Preferably the inside surface of the side wall of the cartridge is ribbed or otherwise profiled to deter tracking of the feedstock, between the side wall and the or each filter element.

The cross flow passage may be filled with a material with a high transverse porosity, such as woven gauze as an alternative or in addition to the moulded grid.

Where two or more filter elements are employed, the elements may be simply stacked together in a cartridge. If desired adjacent filter media may be spaced by a spacer means. Preferably the spacer means is a moulded spacer from the same material as makes the cartridges.

The cartridge may have a single inlet at its open end for lubricant or oil to enter the cartridge. Alternatively the cartridge may have respective inlets at

opposite ends and a shared transverse wall intermediate the opposite ends thus forming back-to-back filters.

Where inlets are provided at both ends of the cartridge the centre tube and the cross flow passages may be arranged between adjacent filter elements on opposite sides of the shared wall.

The filter cartridge is preferably recycled but may be discarded along with the filter element once the or each filter element becomes fully charged with trapped and retained solids.

In a further aspect, the present invention resides in a filter housing for filtering a feedstock including:

- a body or housing;

- an inlet in the housing to allow a supply of feedstock to be filtered from the housing;

- an outlet in the housing to allow flow of filtered feedstock or filtrate from the housing;

- a hollow centre post disposed coaxially within the housing, the wall of the centre post having fluid communication ports between the outside and the bore thereof, the bore being connected to the housing outlet;

- the said filter cartridge within the housing; and

filter cartridge installation means providing releasably sealable installation means providing releasable sealable installation of the filter cartridge in the housing whereby the feedstock flows from the inlet to the outlet through the filter cartridge.

Preferably, the housing is closed at its base and open at its top, the top being closed by a cap fitted with sealing means to engage the wall of the housing.

Preferably, the housing inlet and the housing outlet are at the base of the housing as is a drain port to enable contaminated feedstock to be drained from the bottom of the housing.

Preferably, the open end (ie. inlet) of the (or uppermost) filter cartridge is adjacent the top of the housing so that the feedstock flows from the housing inlet upwardly through an annular passage defined by the wall of the housing and the cartridge.

Preferably, a hollow centre post is disposed within, and sealably connected to, the centre tube.

Preferably, sealing means seal against flow of fluid between the housing and the centre tube, so arranged that filtrate in the centre tube flows through the fluid communication ports into the bore of the centre post, and then to the housing outlet.

Preferably, a filter medium retaining ring is provided about the upper end of the centre tube and bears against the top of the filter medium. A compression spring, about the centre post, is preferably interposed between the housing cap and the retaining ring to urge the retaining ring into engagement with the filter element to seal the upper end of the centre tube and to retain the filter medium in the cartridge.

Preferably, a pressure knob, screw-threadably mounted on the centre post, bears against the closed end of the cartridge to urge the filter cartridge upwardly against the compression spring.

Preferably, respective seal means seal the centre post to the coaxial hole through the retaining ring and the second end of the cartridge.

The filter element, is preferably a roll of facial-quality paper tissue of standard size. However, other non biodegradable filter media may be used, such as, but not limited to, non biodegradable cotton, hemp, artificial or synthetic fibres, or any suitable porous or foraminous material.

The housing, cartridge, centre tube, centre post, lid and other hardware are preferably made from reusable polymeric, ceramic or composite compounds and the like suitable for being recycled.

Preferably, the seals are of an oil resistant elastomer. However, permanently deformed or rigid sealing material may also be used.

The filter cartridge is typically employed in a filter housing. The filter element preferably has a reusable moulded centre core so that upon assembly the filter element and its associated centre core are inserted into the cartridge. The centre core is typically a tube. Subsequently a centre tube is slid into the core, the centre tube having an end flange projecting radially outward and being located around the centre core and in use embedded in the filter element so that

the centre core can be clamped against the filter element to retain same within the cartridge. There is preferably provided sealing means between the centre core and the centre tube to inhibit tracking of filtrant between the centre tube and the core. The centre tube preferably includes a plurality of recesses or grooves in its
5 end that are operatively located adjacent the transverse end wall of the cartridge in order to assist in the tracking of filtrate from the grid and into the centre tube. A filtrate return tube having a small opening is usually located concentrically within the centre tube.

The filter element support grid is preferably a grid of ridges extending
10 across the end wall with some ridges being deeper than other ridges in order to facilitate tracking of filtrate across the transverse end wall. At the same time the ridges are closely spaced in order to provide uniform support for the filter element and to thereby maintain it above and spaced from the end wall of the cartridge to thereby inhibit clogging.

The cartridge preferably has a wide mouth narrowing to a main body, the
15 mouth providing a lead-in guide to lead the filter element into the cartridge during assembly. The centre core of the filter element preferably includes a bevelled lower edge also to assist in leading the core into position in the filter element during assembly. Again the centre tube preferably has a bevelled edge
20 also to facilitate assembly.

In order to inhibit tracking of filtrant around the filter element along the inner wall of the cartridge the cartridge preferably includes internal annular ribbing.

The seal between the centre core and the centre tube is typically formed
25 utilising an annular groove on an outer surface of the centre tube in which an o-ring is located so that the o-ring seals against the core when the centre tube is in place. Other functional equivalents can be employed.

In another aspect the present invention resides that a method for recycling filter cartridges, the method employing a filter element extraction tool to engage
30 and remove a flexible filter element from within a rigid filter cartridge, the tool having filter element gripping means adapted to be inserted into a filter cartridge to engage a spent filter element and to extract the filter element from the

cartridge. The tool typically employs a claw adapted to expand and upon entry into the cartridge close to grip the filter element and hold same so that upon extraction of the tool from within the cartridge the filter element is drawn from the cartridge.

5

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the present invention can be more readily understood and be put into practical effect reference will now be made to the accompanying drawings which illustrate preferred embodiments of the invention and wherein:-

10 Figure 1 is a flow diagram illustrating a preferred example of the method of recycling according to the present invention;

Figure 2 is a perspective view of a typical filter assembly;

Figure 3 is a section through a typical filter assembly;

Figure 4 is a section through another embodiment of the present invention;

Figure 5 is a section illustrating a typical end wall;

15 Figure 6 is a section illustrating a further embodiment of a centre tube suitable for use with a filter assembly according to the present invention.

METHOD OF PERFORMANCE

The following description relates to the preferred use of an improved cartridge used as a recyclable cartridge but it will be appreciated that the cartridge
20 could be used as a disposable cartridge.

Referring to the drawings and initially to Figure 1 there is illustrated in schematic form the recycling method according to the present invention and a preferred tool utilised with that recycling method.

25 As can be seen in the upper left hand corner of the flow diagram a cartridge is made according to the teachings of the present invention and in this case formed from a moulded carbon fibre reinforced plastics material so that the cartridge is sufficiently ridged so that it can be reused. The cartridge is injection moulded using a formulation of 60% by weight nylon melt resin with chopped glass fibre to 40% by weight. The resin has a melt temperature in excess of
30 200°C.

At 11 a filter element is prepared and this involves a 100% cellulose element 12 into which a reusable moulded or otherwise formed reinforced carbon

fibre centre core 13 is pushed. The filter element and core 13 are forced using a press either together or in turn into the cartridge 10.

Now the cartridge 10 in the illustrated embodiment includes an annular flare at 14 which operates as a filter element lead-in guide and assists in feeding the filter element into the cartridge.

The end wall 15 of the cartridge illustrated includes projections to be described further below and the side walls include spaced annular ridges. The projections serve to keep the filter element away from the end wall 15 so that filtrate can track across the end wall 15 into the centre core 13. The annular ridges are used to inhibit tracking of filtrant between the filter element and the walls of the cartridge.

Once the filter element and cartridge are assembled then a centre tube shown at 17 is pushed into the assembly. The centre tube in this case includes sealing means in the form of an o-ring at 18 which seals against the core 13 to inhibit tracking of filtrant between the centre tube 17 and the core 13.

The filter cartridge is then placed in position inside a filter housing to be described as follows.

The housing can be on say a truck depicted schematically at 19 and once the filter element 11 is spent the whole cartridge is returned from the vehicle 19 to the factory for recycling. The central tube 17 is withdrawn and then a suitable tool 20 shown schematically in Figure 1 is used to extract the spent filter element 11 from the cartridge.

As can be seen the tool 20 includes a claw assembly 21 utilising a manually operable expander 22 so that upon insertion of the claw assembly 21 into the filter element 11 the expander 22 can be employed to move the jaws 23 of the claw assembly to the position illustrated at 24. A lever 25 is used to extract the claw assembly 21 and thereby the filter element 11 from the cartridge 10. It will be appreciated once the spent filter element has been removed from the cartridge the cartridge can be reloaded and it can be returned and reused over and over again.

Figures 2 and 3 illustrate how the filter cartridge 10 and its associated element are used in a filter housing while Figure 4 illustrates an alternative

embodiment where the filter cartridge in this case 26 is effectively back-to-back filter assemblies 10 where the filter elements are half size and a central wall having back-to-back grids is formed at 27. The cores and central tubes are all half sized as well and in effect the cartridge illustrated in Figure 4 is back-to-back
5 cartridges 10. This particular cartridge is reused in a similar fashion to the cartridge described earlier and recycled in the same general way. The cartridge of Figure 3 due to its greater capacity is typically used for oil filtering application while the cartridge of the Figure 4 is used for fuel filtration.

A typical end wall of each of the cartridges, illustrated in Figures 3 and
10 4 is shown in Figure 5 while the end of a preferred central tube having flow through passages at 28 is illustrated in Figure 6.

Whilst the above has been given by way of illustrative example of the present invention, many variations and modifications thereto will be apparent to those skilled in the art without departing from the broad ambit and scope of the
15 invention as set forth in the appended claims.

CLAIMS

1. A filter cartridge being adapted to receive a filter element under compression to form a tight fit between the cartridge and the element, the cartridge being hollow and having a side wall that is sufficiently rigid for multiple
5 use involving repeated insertion and removal of filter elements from the cartridge.
2. A filter cartridge according to claim 1 wherein the cartridge is of integral one piece construction the side wall having an inside surface and there being an inner transverse wall, the inner wall including a filter element support grid allowing flow of filtrate across the inner wall of the cartridge through the support
10 grid while at the same time providing fairly uniform support for the filter element across the inner transverse wall of the cartridge.
3. The filter cartridge according to claim 1 or claim 2 wherein the cartridge holds a filter element for a filter, the cartridge including:
an open end forming an inlet for the filter element, a side wall and a
15 second end opposite to the open end of the cartridge;
at least one filter element within the cartridge disposed about a centre tube defining an outflow passage for filtrate so arranged that:
a feedstock to be filtered will pass through the inlet to the or each filter element, and the filtered feedstock or filtrate will pass through a cross flow
20 passage into the outflow passage surrounded by the centre tube;
the or each filter element being wound onto the centre tube in sealing engagement with the centre tube and the side wall of the cartridge;
the feedstock passes substantially axially through the filter medium to the cross flow passage; and
25 wherein the or each filter medium comprises a non biodegradable material.
4. A filter cartridge according to claim 3 wherein the filter element is a tightly wound paper roll, machine wound using virgin pulp paper of suitable strength for machine winding.
5. A filter cartridge according to claim 4 wherein the paper is rated at about
30 and not less than 17 GSM.
6. A filter cartridge according to claim 5 wherein the paper is adhered to the roll by an inert adhesive.

7. A filter cartridge according to claim 2 wherein the filter element is wound from 43m to 46m of paper.
8. A filter cartridge according to claim 2 wherein the inside surface of the side wall of the cartridge is ribbed or otherwise profiled to deter tracking of the feedstock along the side wall of the cartridge.
9. A filter cartridge according to claim 1 wherein the cartridge has respective inlets at opposite ends and a shared transverse wall intermediate the opposite ends thus forming back-to-back filters.
10. A filter assembly having a filter cartridge according to claim 1 in combination with a filter housing for filtering a feedstock including:
- a body or housing;
 - an inlet in the housing to allow a supply of feedstock to be filtered from the housing;
 - an outlet in the housing to allow flow of filtered feedstock or filtrate from the housing;
 - a hollow centre post disposed coaxially within the housing, the wall of the centre post having fluid communication ports between the outside and the bore thereof, the bore being connected to the housing outlet;
 - the said filter cartridge within the housing; and
- filter cartridge installation means providing releasably sealable installation means providing releasable sealable installation of the filter element(s) in the housing whereby the feedstock flows from the inlet to the outlet through the filter cartridge.
11. A filter assembly according to claim 10 wherein the housing is closed at its base and open at its top, the top being closed by a cap fitted with sealing means to engage the wall of the housing, the housing inlet and the housing outlet being at the base of the housing as is a drain port to enable contaminated feedstock to be drained from the bottom of the housing.
12. A filter assembly according to claim 11 wherein sealing means seal against flow of fluid between the housing and the centre tube, so arranged that filtrate in the centre tube flows through the fluid communication ports into the bore of the centre post, and then to the housing outlet.

13. A filter assembly according to claim 12 wherein a filter medium retaining ring is provided about the upper end of the centre tube and bears against the top of the filter cartridge, a compression spring, about the centre post, is preferably interposed between the housing cap and the retaining ring to urge the retaining ring into engagement with the filter element to seal the upper end of the centre tube and to retain the filter medium in the cartridge.
14. A cartridge according to claim 2 wherein the filter element has a reusable moulded centre core so that upon assembly the filter element and its associated centre core are inserted into the cartridge, a centre tube inside the core, the centre tube having an end flange projecting radially outward and being located around the centre core and being embedded in the filter element so that the centre core can be clamped against the filter element to retain same within the cartridge.
15. A cartridge according to claim 14 including sealing means between the centre core and the centre tube to inhibit tracking of filtrant between the centre tube and the core.
16. A cartridge according to claim 14 wherein the centre tube includes a plurality of recesses or grooves in its end that are operatively located adjacent the transverse end wall of the cartridge in order to assist in the tracking of filtrate from the grid and into the centre tube.
17. A filter cartridge according to claim 2 wherein the filter element support grid is a grid of ridges extending across the transverse wall with some ridges being deeper than other ridges in order to facilitate tracking of filtrate across the transverse wall.
18. A filter assembly according to claim 1 or claim 2 where the cartridge has a wide mouth narrowing to a main body, the mouth providing a lead-in guide to lead a filter element into the cartridge during assembly.
19. A filter cartridge according to claim 14 wherein the centre core of the filter element includes a bevelled lower edge also to assist in leading the core into position in the filter element during assembly.
20. A filter cartridge according to claim 14 wherein the centre core and the centre tube is formed utilising an annular groove on an outer surface of the centre

tube in which an o-ring is located so that the o-ring seals against the core when the centre tube is in place.

21. a method for recycling a filter cartridge comprising the steps of:-

- (i) Providing a recyclable filter cartridge;
- 5 (ii) Inserting a filter element into the cartridge;
- (iii) Subsequently inserting the filter cartridge and element contained therein into a filter housing in a vehicle;
- (iv) Carrying out a filtering process with the filter cartridge and the filter element until the element is spent;
- 10 (v) Removing the filter cartridge and spent element from the filter housing;
- (vi) Extracting the spent filter element from the cartridge;
- (vii) Reusing the cartridge by repeating steps (i) - (vii).

22. A method for recycling filter cartridges according to claim 21, the method
15 employing a filter element extraction tool to engage and remove a flexible filter element from within a rigid filter cartridge, the tool having filter element gripping means adapted to be inserted into a filter cartridge to engage a spent filter element and to extract the filter element from the cartridge.

23. The method according to claim 21 wherein the tool employs a claw
20 adapted to expand and upon entry into the cartridge close to grip the filter element and hold same so that upon extraction of the tool from within the cartridge the filter element is drawn from the cartridge.

24. A cartridge according to claim 1 wherein the cartridge is injection moulded using a glass fibre reinforced nylon having a melt temperature in excess of 200°C.

25. The method according to claim 21 wherein the cartridge is injection
25 moulded using a glass fibre reinforced nylon having a melt temperature in excess of 200°C.

26. The method according to claim 22 wherein the cartridge is injection
30 moulded using a glass fibre reinforced nylon having a melt temperature in excess of 200°C.

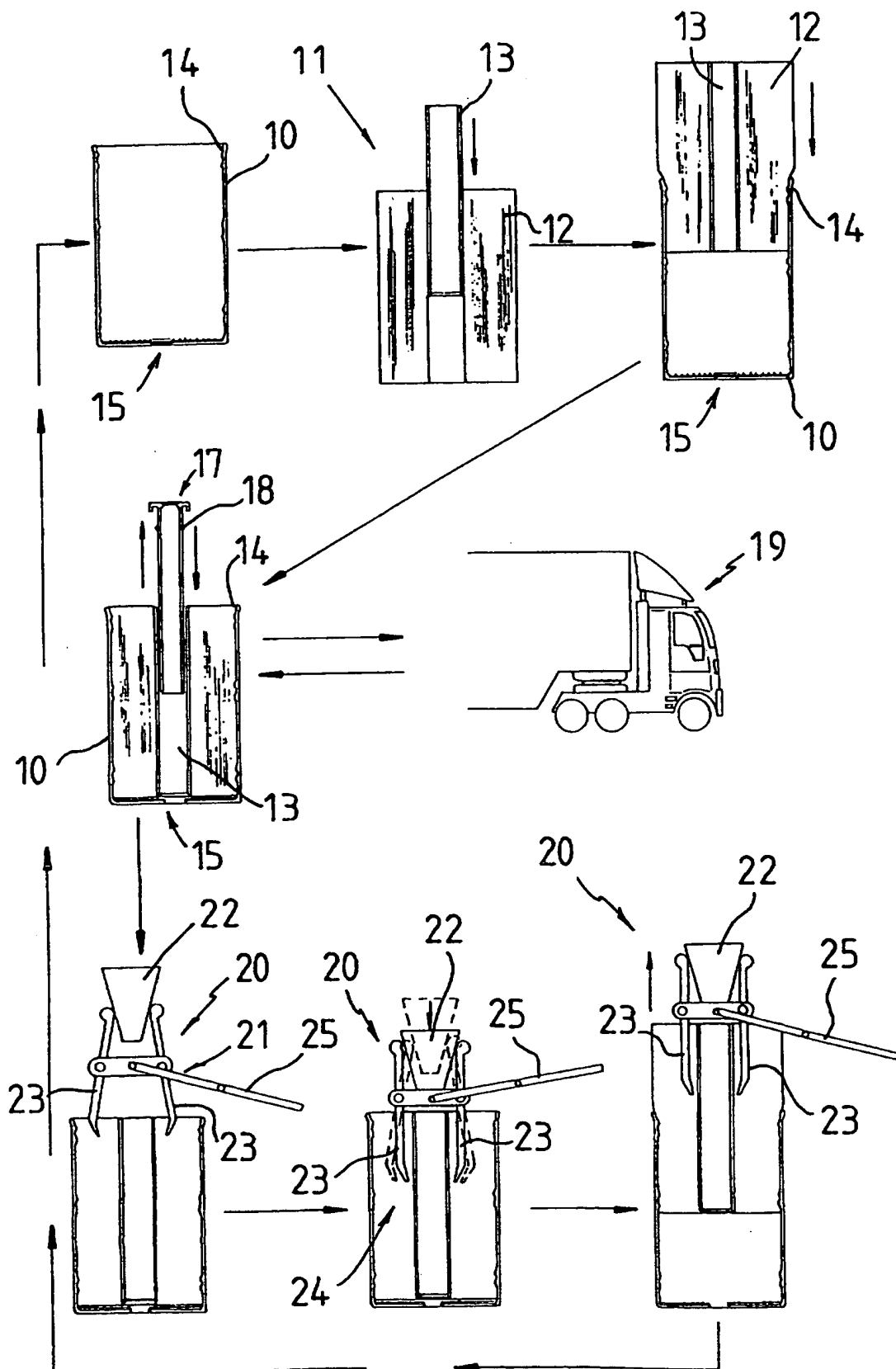


FIG. 1
SUBSTITUTE SHEET (RULE 26)

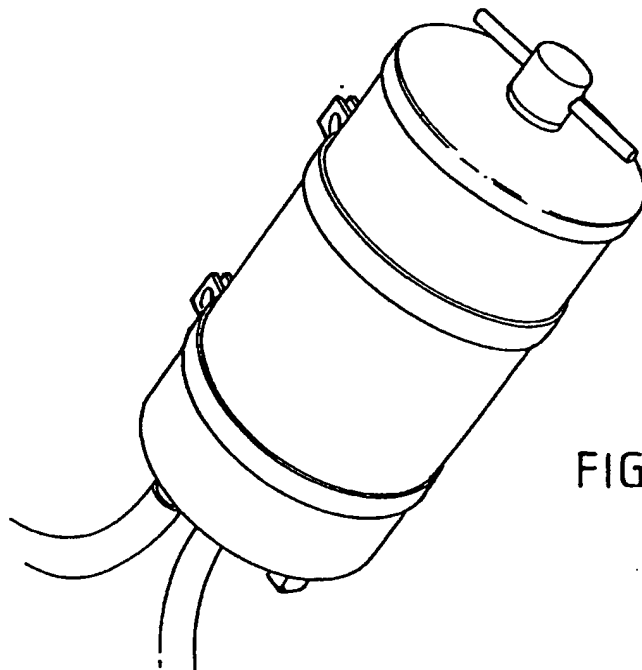


FIG. 2

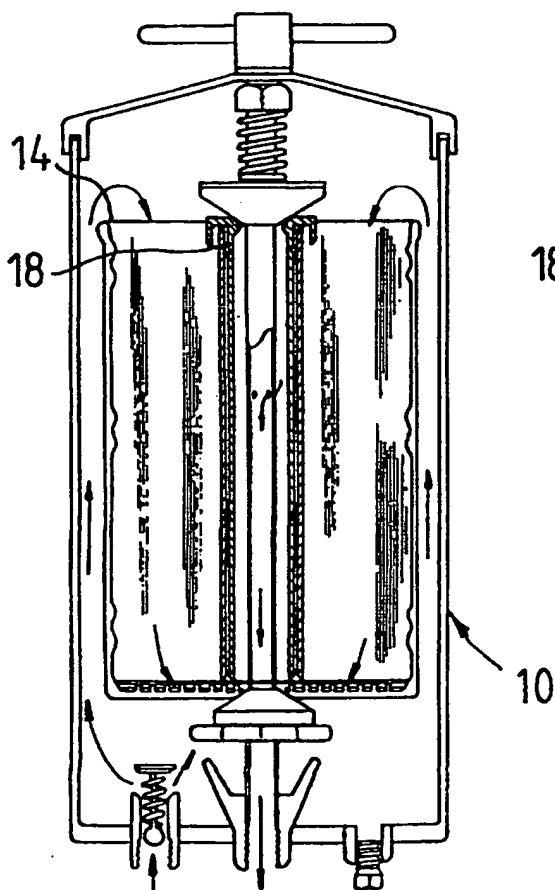


FIG. 3

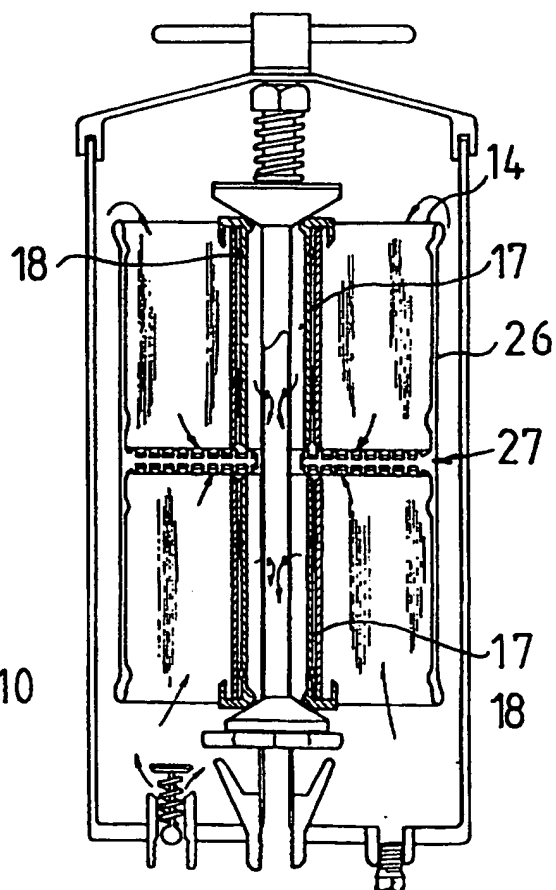


FIG. 4

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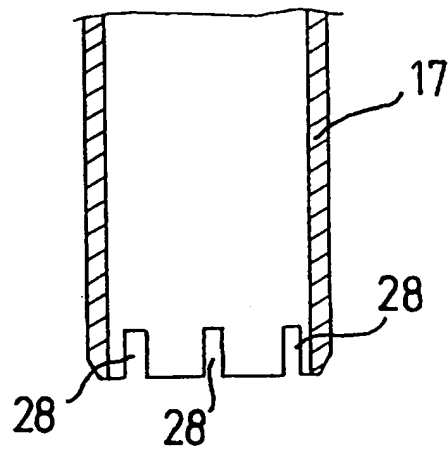


FIG 6

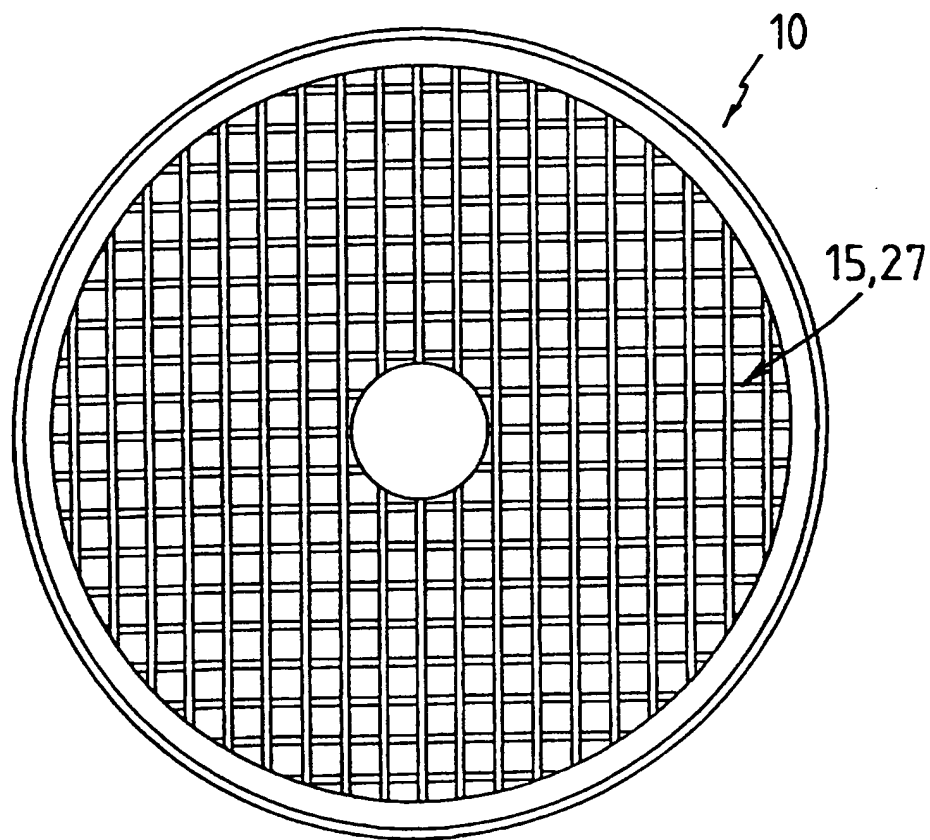
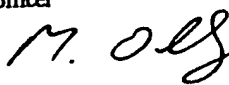


FIG. 5

INTERNATIONAL SEARCH REPORT

International Application N .

PCT/AU 96/00762

A. CLASSIFICATION OF SUBJECT MATTER				
Int Cl ⁶ : BOID 27/08, BOID 35/30				
According to International Patent Classification (IPC) r to both national classification and IPC				
B. FIELDS SEARCHED				
Minimum documentation searched (classification system followed by classification symbols) IPC ⁶ BOID 27/08, BOID 35/30				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU: IPC as above				
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Derwent				
C. DOCUMENTS CONSIDERED TO BE RELEVANT				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
X	AU B 78/66 (414751) (SKY CENTER CORPORATION) 6 July 1967, see whole document	(1-7), 14,15,18,21		
P,X	AU A 28259/95 (JONES et al) 21 December 1995 see whole document	1		
X	US A 5342519 (FREIDMANN) 30 August 1994 see whole document	1		
<input type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex				
<p>* Special categories of cited documents:</p> <table border="0"> <tr> <td style="vertical-align: top;"> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> </td> <td style="vertical-align: top;"> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p> </td> </tr> </table>			<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>
<p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>			
Date of the actual completion of the international search 2 April 1997		Date of mailing of the international search report 09.04.97		
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (06) 285 3929		Authorized officer  M. Olley Telephone No.: (06) 283 2143		

INTERNATIONAL SEARCH REPORT

International Application No.

Information on patent family members

PCT/AU 96/00762

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
AU	95 28259	WO	9534368	CA	2192985		
US	5342519	AU	73381/94	BR	9407109	CA	2168112
		CN	1127994	EP	711196	JP	9500827
		WO	9503871	ZA	9405624		
END OF ANNEX							